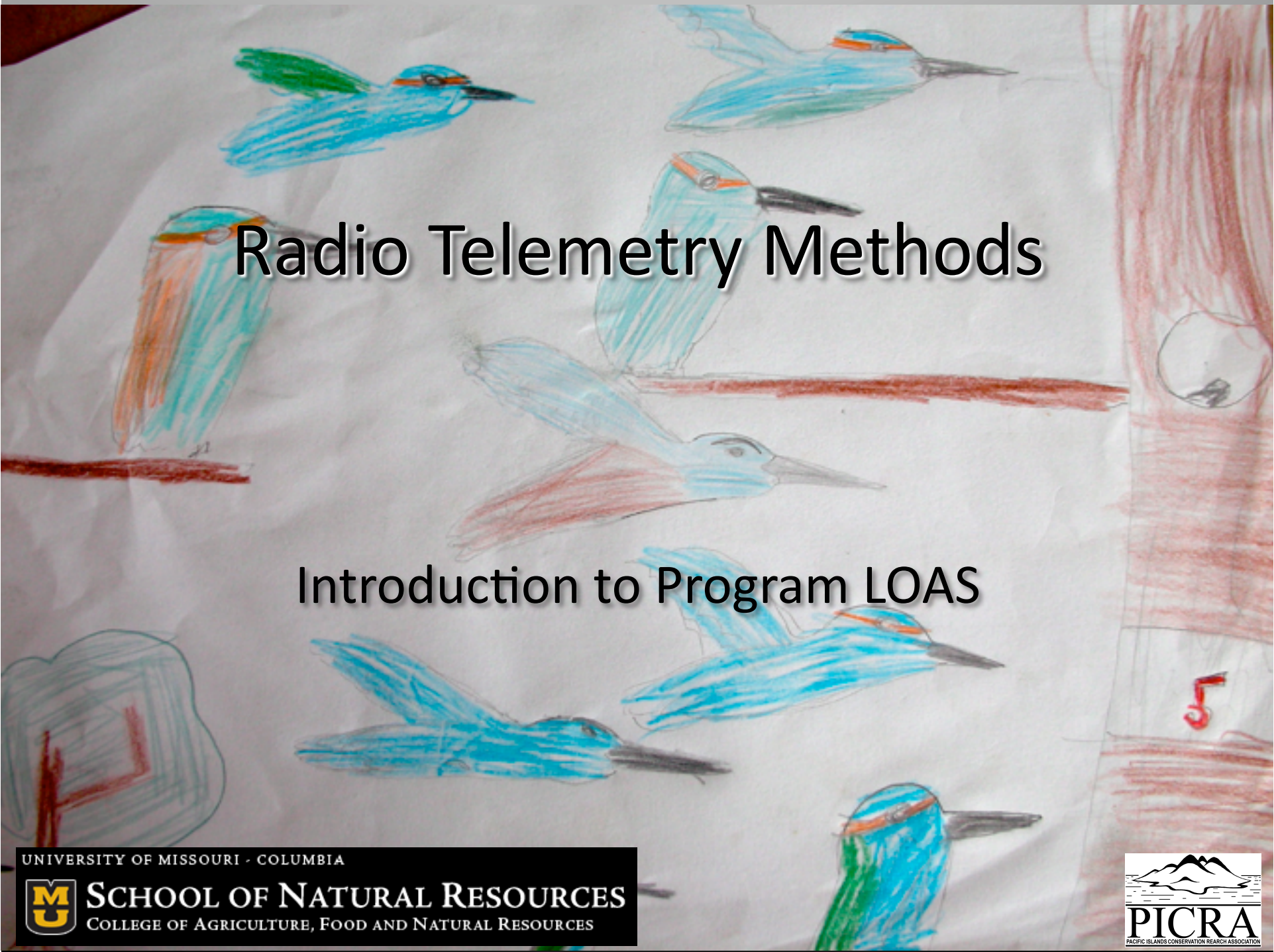




# Radio Telemetry Methods

## Introduction to Program LOAS

UNIVERSITY OF MISSOURI - COLUMBIA



**SCHOOL OF NATURAL RESOURCES**  
COLLEGE OF AGRICULTURE, FOOD AND NATURAL RESOURCES



# Overview

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1. *Field data.*
2. *Data preparation for LOAS.*
3. *Importing data into LOAS.*
4. *Marking birds and azimuth groups.*
5. *Selecting estimators.*
6. *Running calculations.*
7. *Exporting data.*

# Radio Telemetry

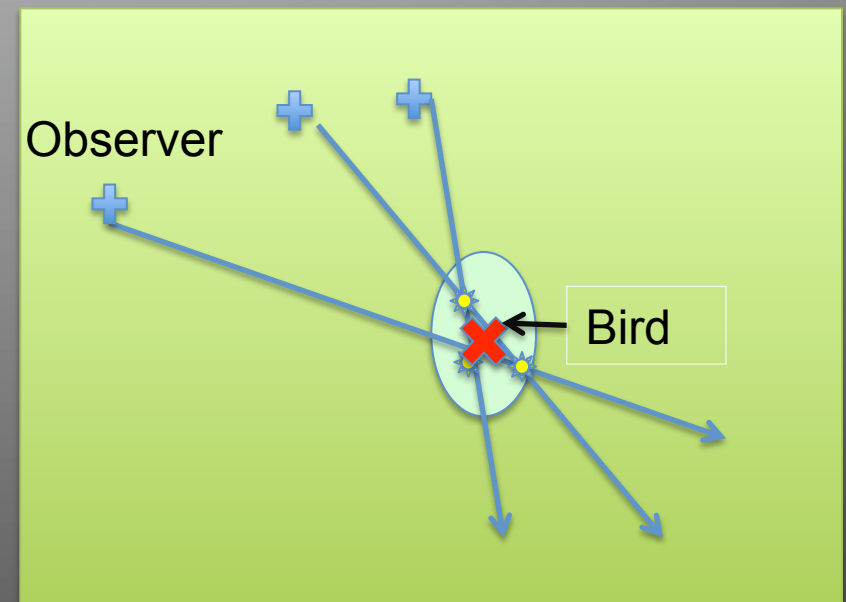
---



- *Location estimates.*
  - *Two methods.*
  - *Actual observation.*
    - *Potentially more accurate.*
    - *Potential to affect bird behavior.*
  - *Triangulation.*
    - *Detection from a distance.*
    - *Must estimate bird location.*
- *Demography.*
  - *Not addressed in this talk.*

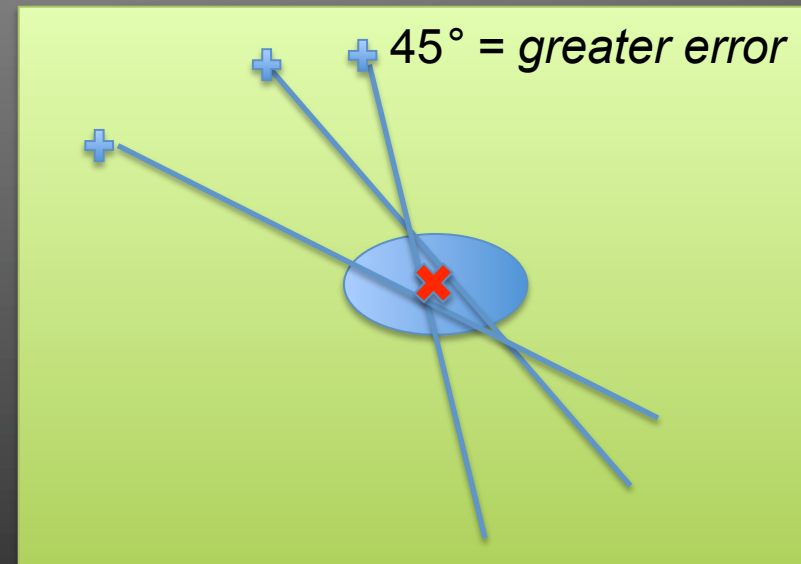
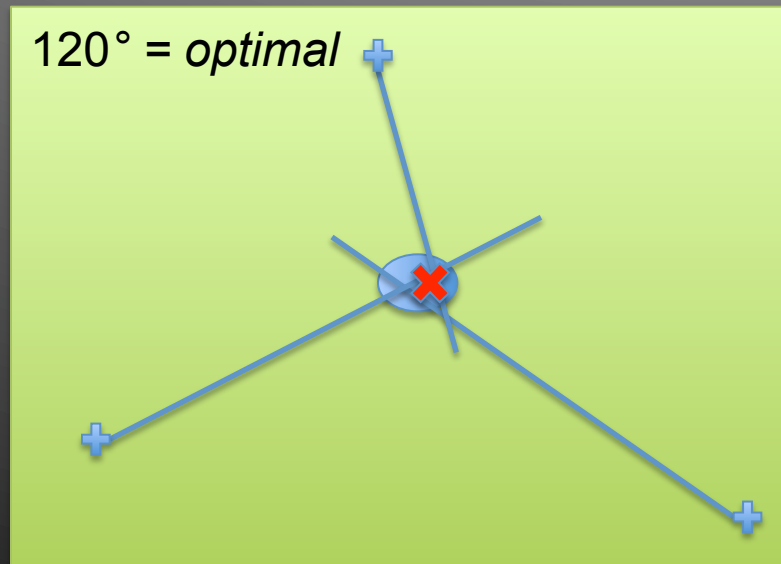
# General Overview

- *Objectives*
  - *Estimate location of bird.*
  - *Estimate error associated with location.*
- *Multiple bearings*
- *Two bearings yield bird location. No estimate of error.*
- *Three+ bearings yield estimate of bird location AND error.*



# Field Techniques

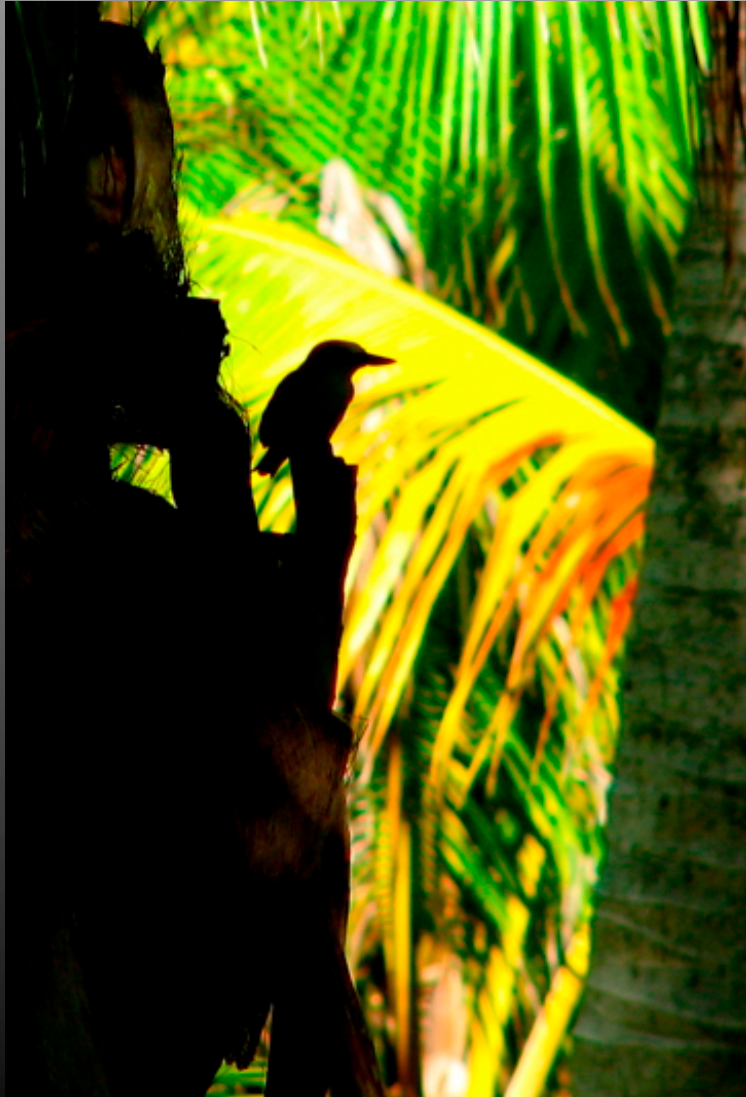
- *Optimizing bearing angles*
  - *Best angles =  $360^\circ/x$ , where  $x$  = number of bearings.*
  - *E.g.  $360^\circ / 3 \text{ bearings} = 120^\circ$*
- *Multiple bearings*
  - *More bearings is better*



Saltz, D. 1994. Reporting error measures in radio location by triangulation. *Journal of Wildlife Management* 58:181-184.

# Field Exercise

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- 1. Record bearing information on data sheets.
- 2. Send one member of group to main computer to enter data.
- 3. Work with data.

# Correcting Magnetic Declination

- Concept
  - Magnetic North Pole
  - True North Pole
  - Declination is difference

- Online calculator

<http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp>

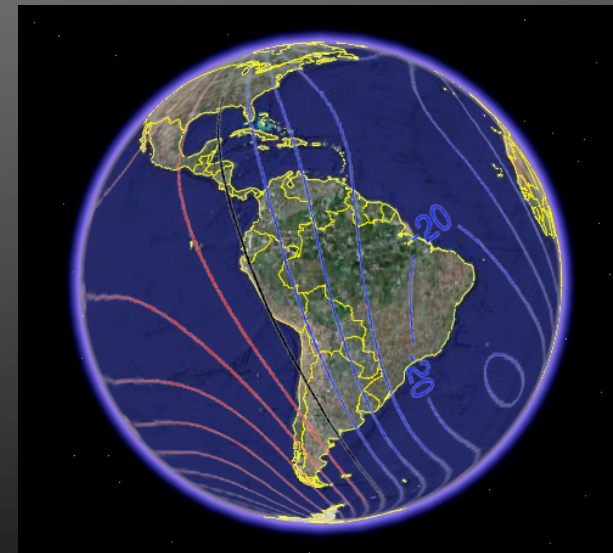
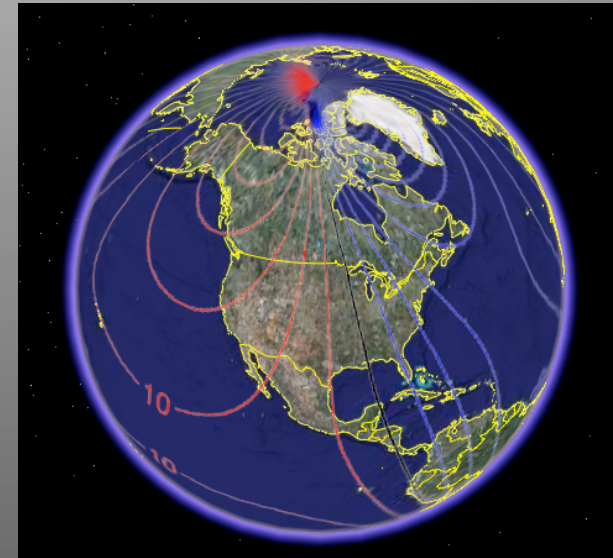
- Correction for east

True Azimuth = magnetic bearing – correction  
degrees - (correction minutes/60)

e.g.

Mazatlan= 23.1° N 106.2° W

True Azimuth = magnetic bearing - 8° - (37'/60')



# Data Required for Location Estimate



## Data Needed

1. Your location
2. Azimuth to bird
3. Magnetic declination

<http://www.ngdc.noaa.gov/geomagmodels/Declination.jsp>

## Assumptions

1. Bird is not moving
2. Accuracy of telemetry, azimuth, and declination

*Saltz, D. 1994. Reporting error measures in radio location by triangulation. Journal of Wildlife Management 58:181-184.*

# Working with Large Data Set

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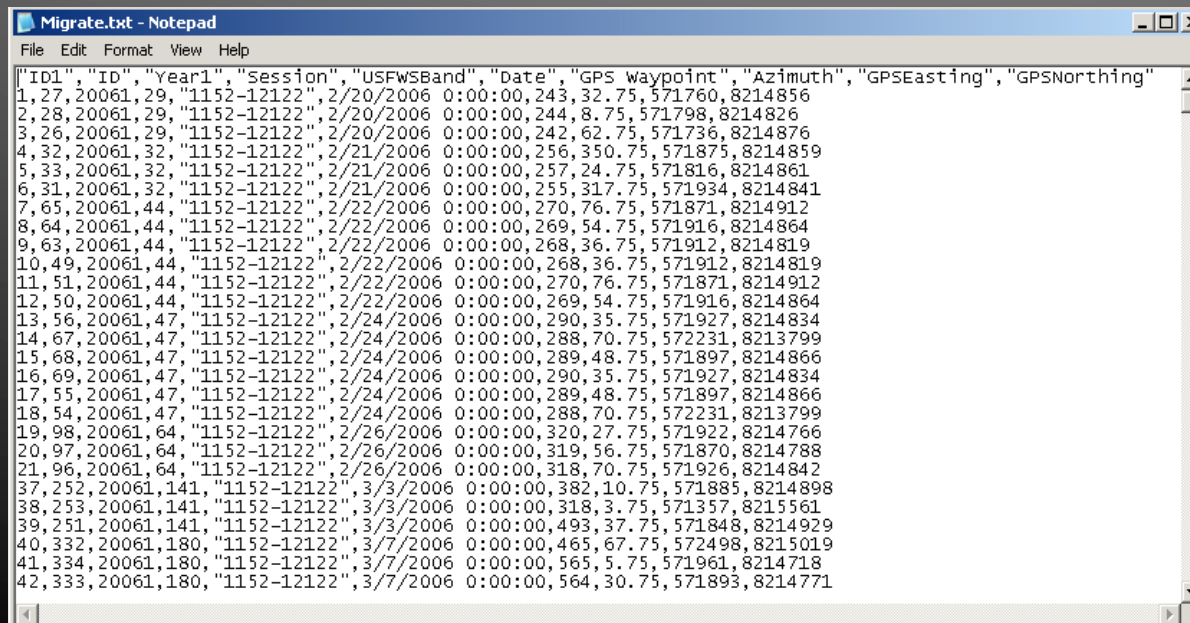
## 1. *Tuamotu Kingfisher data!!*

- *Collected over several years.*
- *Filtered for your benefit.*
- *Compiled for this exercise.*



# Data Organization

- *Data organization*
  - Tab delimited.
  - Comma delimited text file.
  - Use any text editor.
- Required fields
  1. Bird identification.
  2. Bearing group identification.
  3. Corrected azimuth.
  4. Observer Location (X and Y coordinates).



```
File Edit Format View Help
["ID1","ID","Year1","Session","USFWSBand","Date","GPS waypoint","Azimuth","GPSEasting","GPSNorthing"]
1,27,20061,29,"1152-12122",2/20/2006 0:00:00,243,32.75,571760,8214856
2,28,20061,29,"1152-12122",2/20/2006 0:00:00,244,8.75,571798,8214826
3,26,20061,29,"1152-12122",2/20/2006 0:00:00,242,62.75,571736,8214876
4,32,20061,32,"1152-12122",2/21/2006 0:00:00,256,350.75,571875,8214859
5,33,20061,32,"1152-12122",2/21/2006 0:00:00,257,24.75,571816,8214861
6,31,20061,32,"1152-12122",2/21/2006 0:00:00,255,317.75,571934,8214841
7,65,20061,44,"1152-12122",2/22/2006 0:00:00,270,76.75,571871,8214912
8,64,20061,44,"1152-12122",2/22/2006 0:00:00,269,54.75,571916,8214864
9,63,20061,44,"1152-12122",2/22/2006 0:00:00,268,36.75,571912,8214819
10,49,20061,44,"1152-12122",2/22/2006 0:00:00,268,36.75,571912,8214819
11,51,20061,44,"1152-12122",2/22/2006 0:00:00,270,76.75,571871,8214912
12,50,20061,44,"1152-12122",2/22/2006 0:00:00,269,54.75,571916,8214864
13,56,20061,47,"1152-12122",2/24/2006 0:00:00,290,35.75,571927,8214834
14,67,20061,47,"1152-12122",2/24/2006 0:00:00,288,70.75,572231,8213799
15,68,20061,47,"1152-12122",2/24/2006 0:00:00,289,48.75,571897,8214866
16,69,20061,47,"1152-12122",2/24/2006 0:00:00,290,35.75,571927,8214834
17,55,20061,47,"1152-12122",2/24/2006 0:00:00,289,48.75,571897,8214866
18,54,20061,47,"1152-12122",2/24/2006 0:00:00,288,70.75,572231,8213799
19,98,20061,64,"1152-12122",2/26/2006 0:00:00,320,27.75,571922,8214766
20,97,20061,64,"1152-12122",2/26/2006 0:00:00,319,56.75,571870,8214788
21,96,20061,64,"1152-12122",2/26/2006 0:00:00,318,70.75,571926,8214842
37,252,20061,141,"1152-12122",3/3/2006 0:00:00,382,10.75,571885,8214898
38,253,20061,141,"1152-12122",3/3/2006 0:00:00,318,3.75,571357,8215561
39,251,20061,141,"1152-12122",3/3/2006 0:00:00,493,37.75,571848,8214929
40,332,20061,180,"1152-12122",3/7/2006 0:00:00,465,67.75,572498,8215019
41,334,20061,180,"1152-12122",3/7/2006 0:00:00,565,5.75,571961,8214718
42,333,20061,180,"1152-12122",3/7/2006 0:00:00,564,30.75,571893,8214771
```

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LOAS:

<http://www.ecostats.com/>

Data:

<http://web.missouri.edu/keslerd>

- download Migrate.txt

User ID: Dylan Kesler

Password1: 744708414-319204307

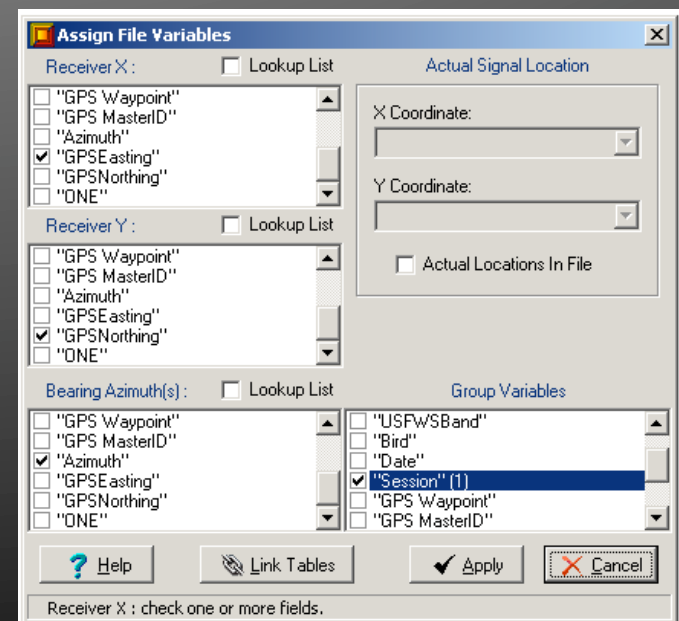
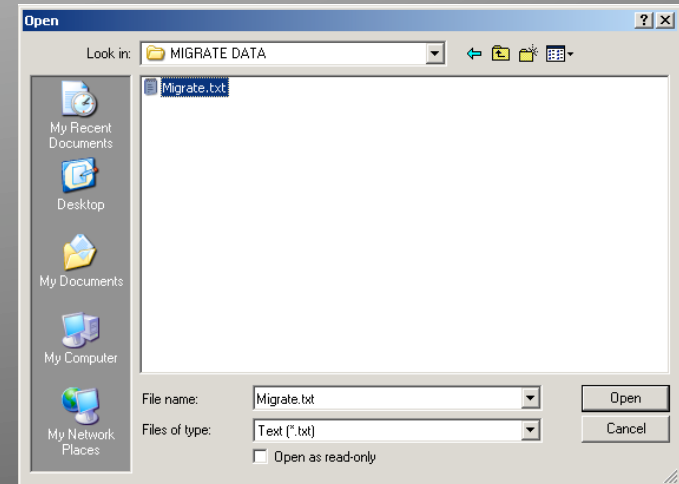
Password2: 846950847-362971027

Password3: 754783320-323519795

Password4: 664779665-284920722

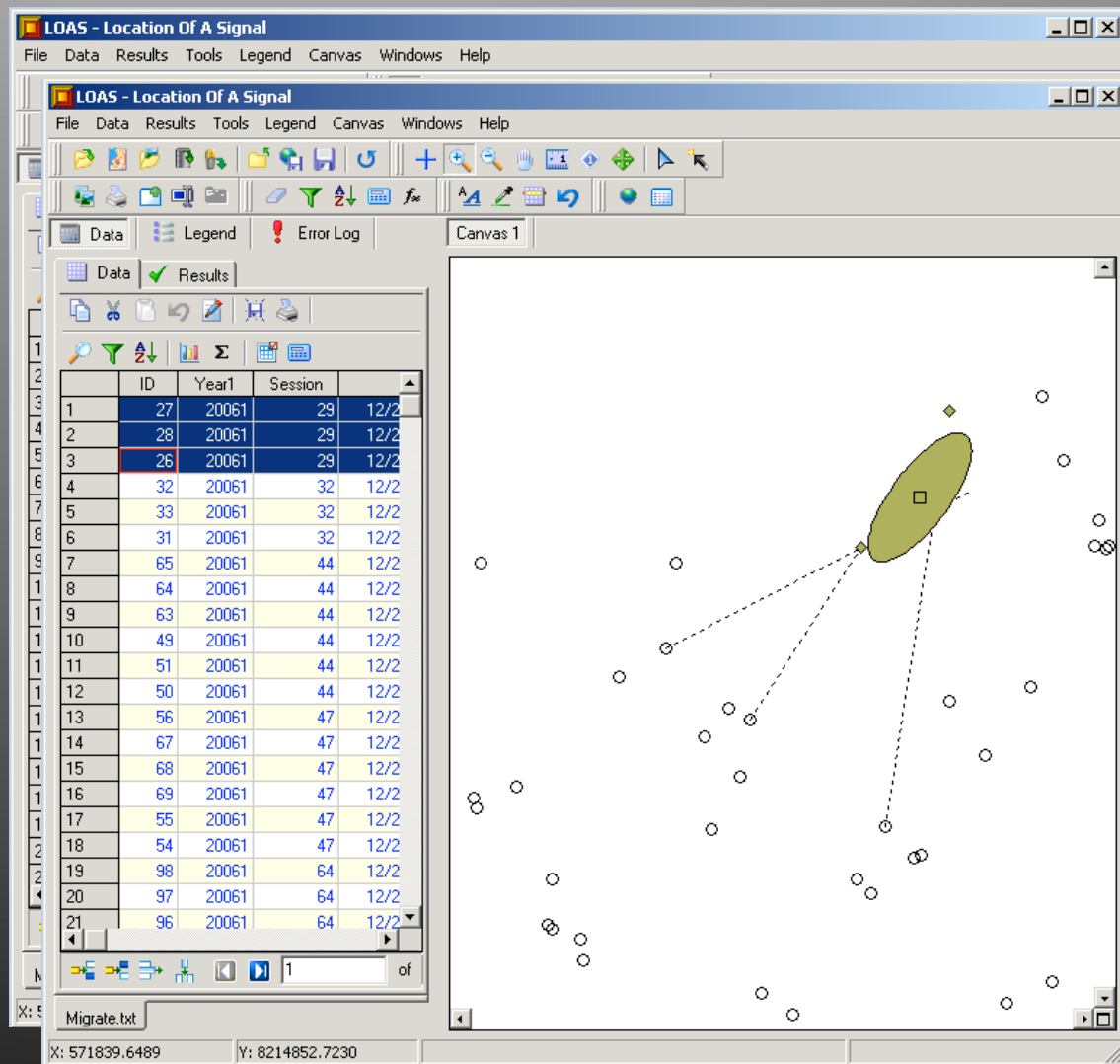
# Opening Data

1. *Start LOAS*
2. *Open File*
  - a. *File, Open Data File*
  - b. *Navigate to the Desktop*
  - c. *Look in "MIGRATE" folder*
  - d. *At bottom, select "File of Type = Text (\*.txt)"*
  - e. *Double click "Migrate.txt"*
3. *Defining File Variables*
  - a. *Receiver X – select "GPSEasting"*
  - b. *Receiver Y – select "GPSNorthing"*
  - c. *Bearing Azimuth – select "Azimuth"*
  - d. *Group Variables – select "Session"*
4. *Click Apply*



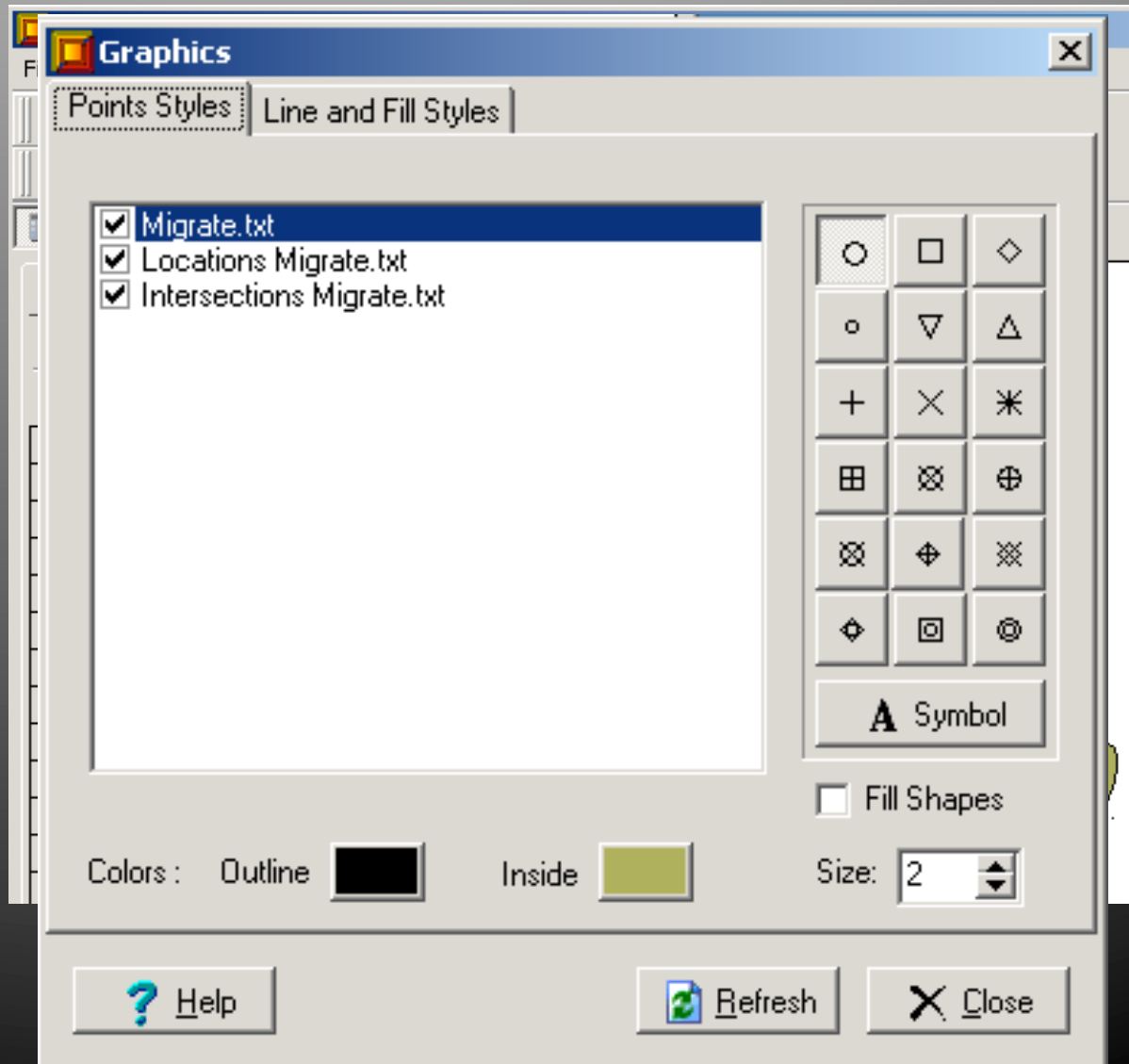
# LOAS Screen Overview

- *Data tab*
- *Results tab*
- *Observer locations*
- *Highlighting bearing groups (sessions)*
- *Exercise*
  - Highlight lines 1,2,3 (session 29)*
  - Click calculate*
  - Zoom into center*
  - Notice three bearings, intersections, estimated location.*
- *These are your estimated locations.*
- *Click the "Results" tab for coordinates.*



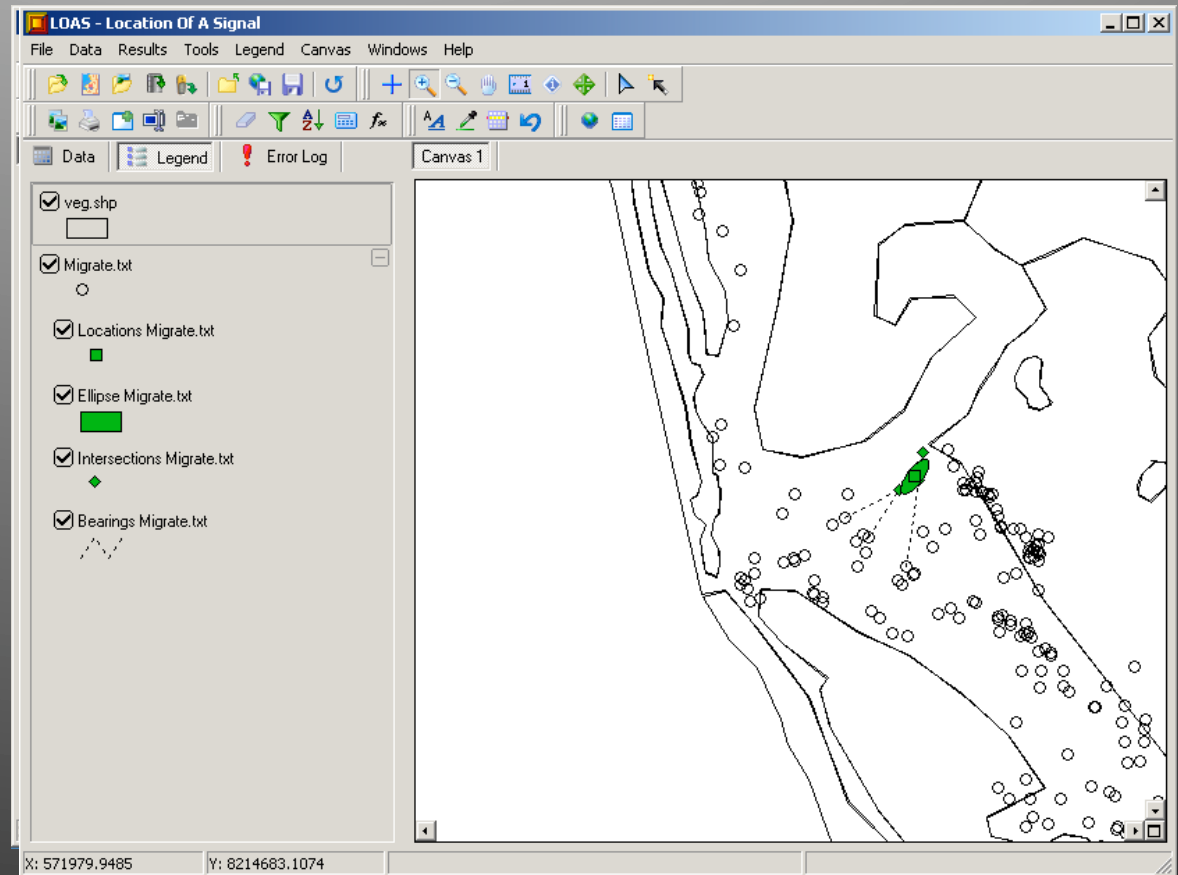
# Adjusting View

- *Adjust symbols and colors*
  - Click “Canvas”*
  - Click “Shapes”*
  - Click “Colors and Symbols”*
  - Adjust colors and symbols.*



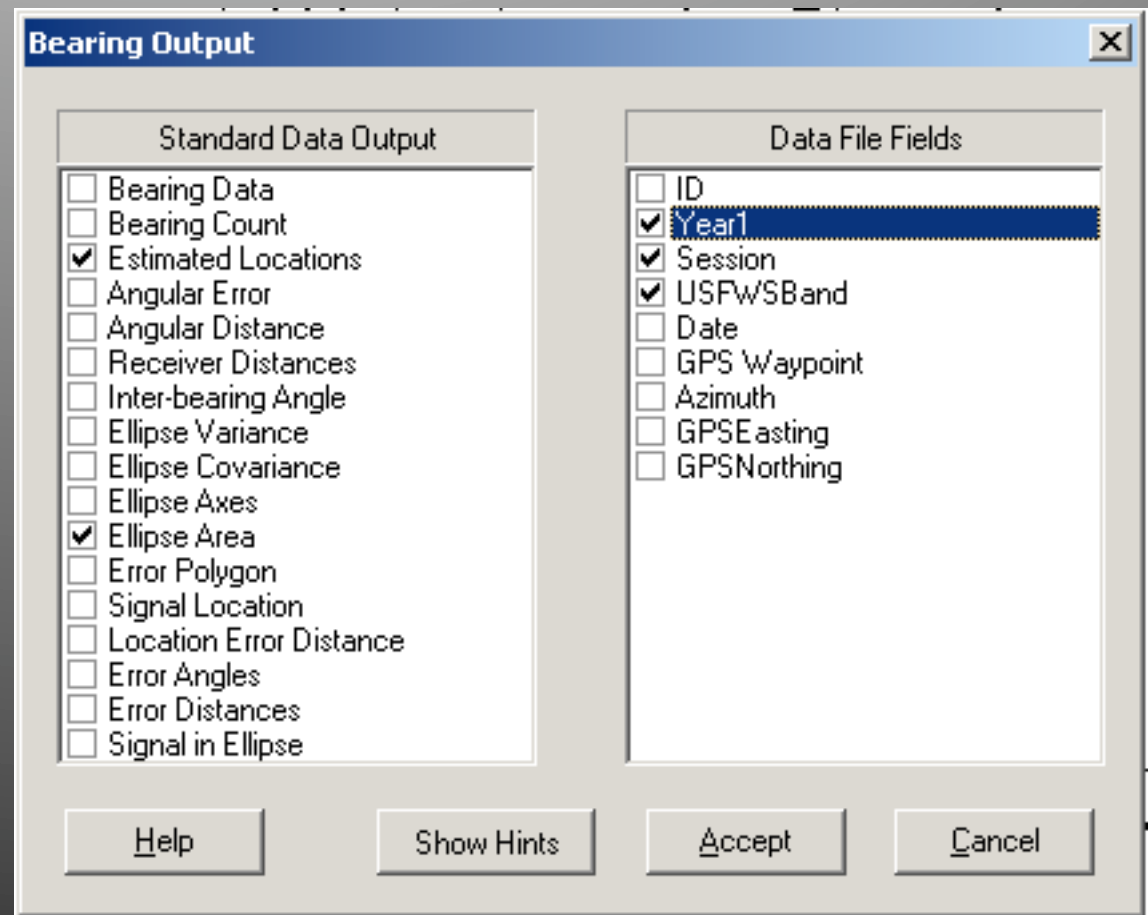
# Adding Arc Shapefiles

- Add Vegetation Cover Layer
  - a) Click “File”
  - b) Click “Open Map Vector File”
- Navigate to the desktop and MIGRATE folder.
  - a) Select “Veg.shp”
  - b) You will see vegetation coverages for the island of Niau.
  - c) Observations are on the right
-  Zoom in with magnifying glass to see bird location within vegetation.
- This bird was located in coconut plantation!!!



# Running Batches of Data

- Click Results tab
-  Clean Results
  - a) Click results tab
  - b) Erase results
- Select Output Variables
  - a) Click "Results"
  - b) Click "Select Output Variables"
  - c) Select
    - ✓ Estimated locations
    - ✓ Ellipse area
    - ✓ Year1
    - ✓ Session
    - ✓ USFWS band
  - d) Click Accept



The image shows a software dialog box titled "Bearing Output". It contains two main sections: "Standard Data Output" and "Data File Fields".

**Standard Data Output:**

- ☐ Bearing Data
- ☐ Bearing Count
- ☒ Estimated Locations
- ☐ Angular Error
- ☐ Angular Distance
- ☐ Receiver Distances
- ☐ Inter-bearing Angle
- ☐ Ellipse Variance
- ☐ Ellipse Covariance
- ☐ Ellipse Axes
- ☒ Ellipse Area
- ☐ Error Polygon
- ☐ Signal Location
- ☐ Location Error Distance
- ☐ Error Angles
- ☐ Error Distances
- ☐ Signal in Ellipse

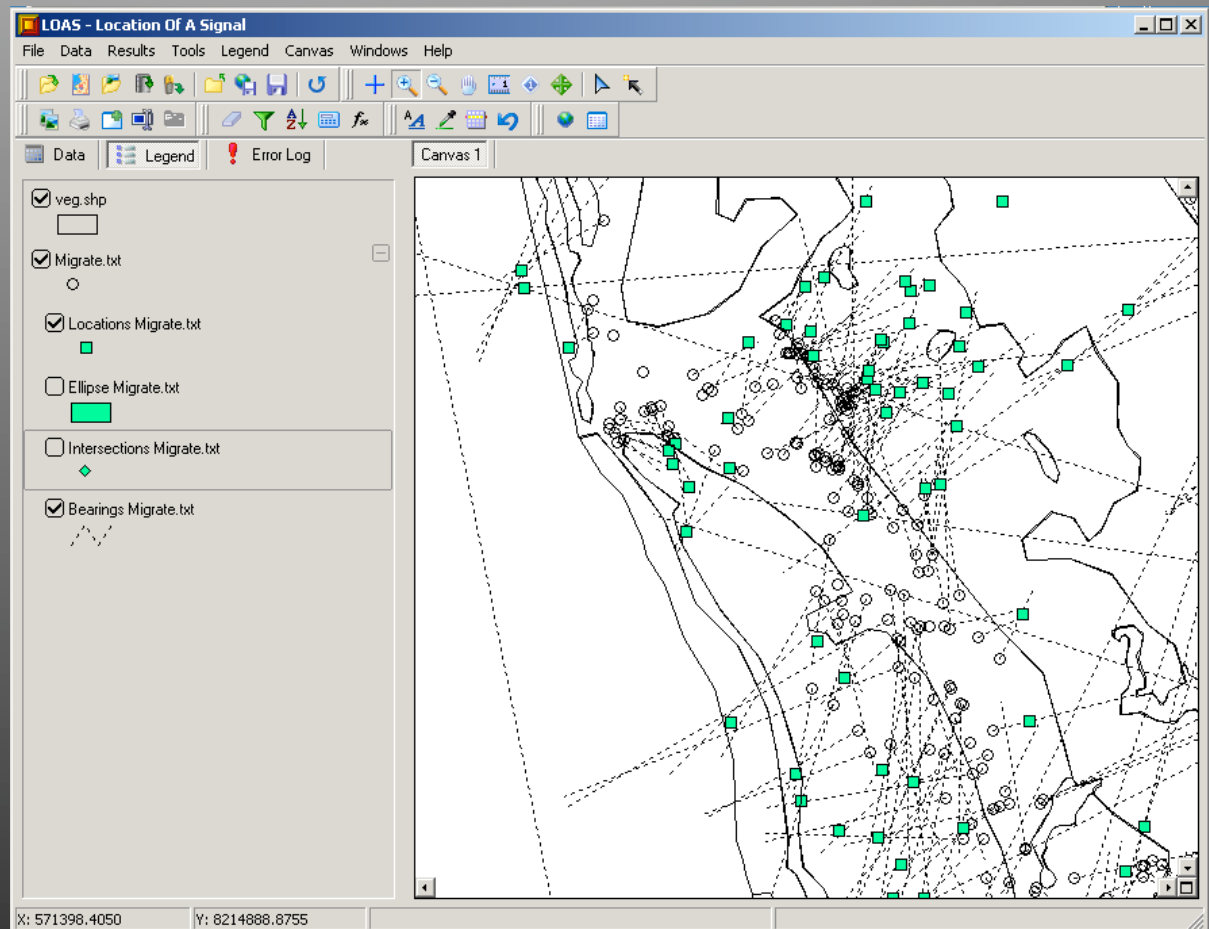
**Data File Fields:**

- ☐ ID
- ☒ Year1
- ☒ Session
- ☒ USFWSBand
- ☐ Date
- ☐ GPS Waypoint
- ☐ Azimuth
- ☐ GPSEasting
- ☐ GPSNorthing

At the bottom of the dialog box are four buttons: "Help", "Show Hints", "Accept", and "Cancel".

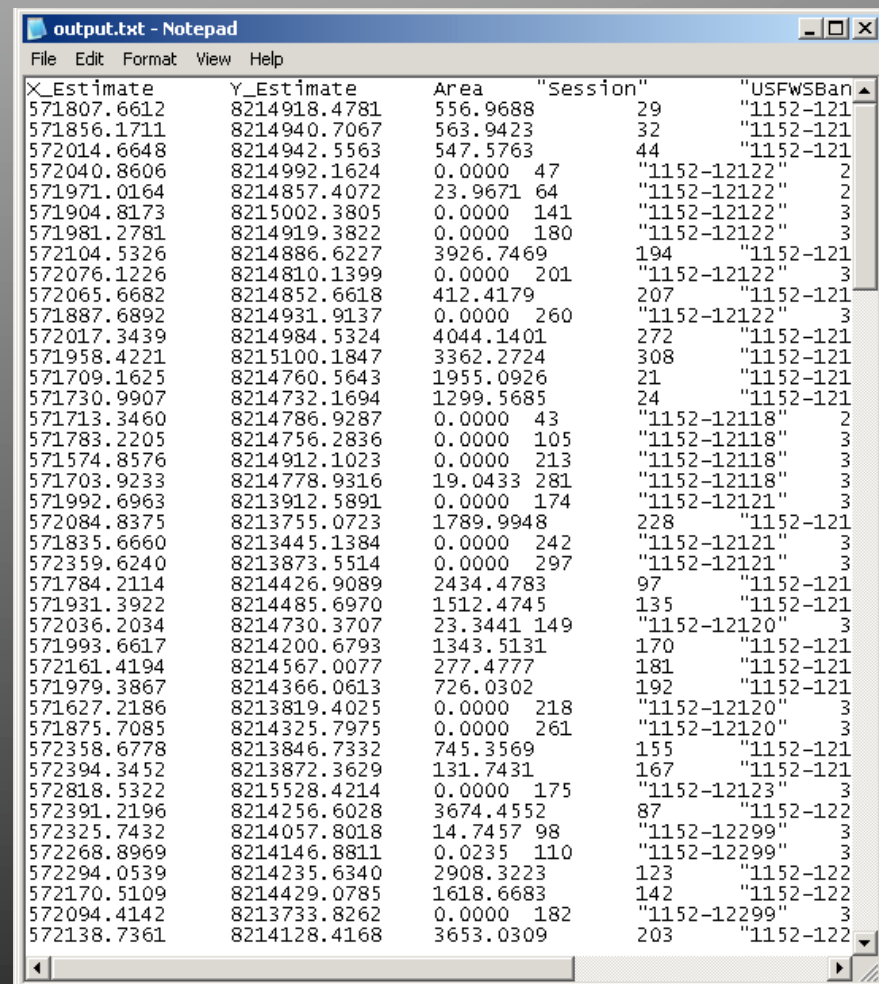
# Generating Results

- Run bearing session 29
-  Click on “Results” tab
  - a) Scroll thorough
  - b) Notice estimated bird location coordinates “X\_Estimate” “Y\_Estimate”
  - c) Notice the area within the error ellipse “Area”.
- Run all data together
  - a) Clear results table
  - b) Select all rows
  - c) Click calculate
  - d) Look at results table!
  - e) Zoom in and look at points on map!



# Exporting Results

1. Click File, Save Data, Telemetry Results.
2. Save all data in grid, and click "Accept"
3. Select the file name, file type (txt works well for arc), and location. Click "Continue"
4. Click "Accept"
5. Done!
6. Double click file to open!
7. These data can be imported into ArcView and analyzed there.



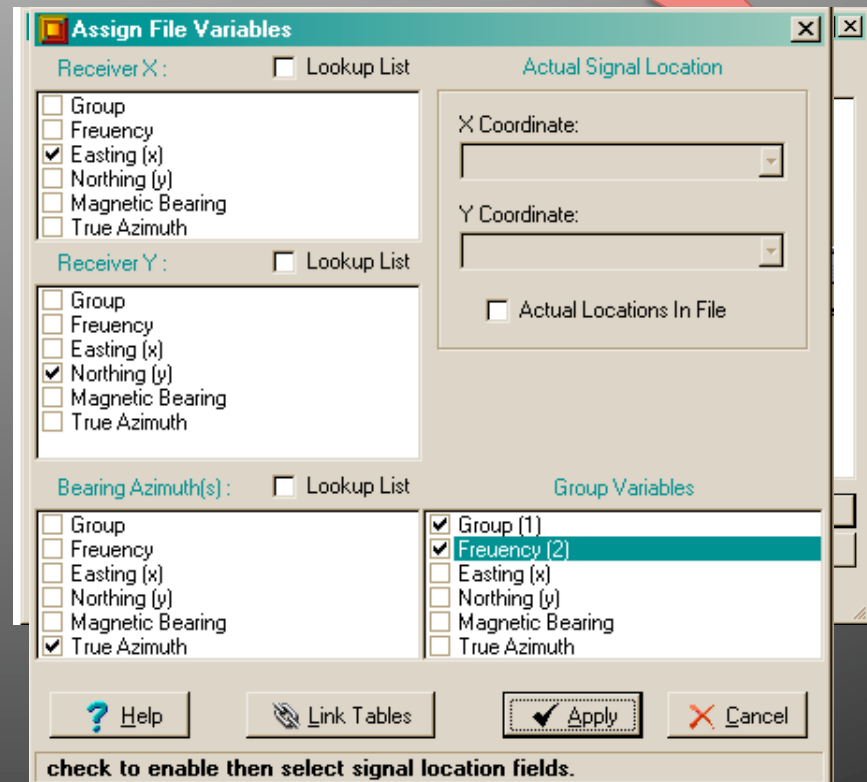
The screenshot shows a Notepad window titled "output.txt - Notepad" with a menu bar (File, Edit, Format, View, Help). The text content is a table with five columns: X\_Estimate, Y\_Estimate, Area, "Session", and "USFWSBan". The data consists of 40 rows of numerical and string values.

| X_Estimate  | Y_Estimate   | Area      | "Session" | "USFWSBan"   |
|-------------|--------------|-----------|-----------|--------------|
| 571807.6612 | 8214918.4781 | 556.9688  | 29        | "1152-121"   |
| 571856.1711 | 8214940.7067 | 563.9423  | 32        | "1152-121"   |
| 572014.6648 | 8214942.5563 | 547.5763  | 44        | "1152-121"   |
| 572040.8606 | 8214992.1624 | 0.0000    | 47        | "1152-12122" |
| 571971.0164 | 8214857.4072 | 23.9671   | 64        | "1152-12122" |
| 571904.8173 | 8215002.3805 | 0.0000    | 141       | "1152-12122" |
| 571981.2781 | 8214919.3822 | 0.0000    | 180       | "1152-12122" |
| 572104.5326 | 8214886.6227 | 3926.7469 | 194       | "1152-121"   |
| 572076.1226 | 8214810.1399 | 0.0000    | 201       | "1152-12122" |
| 572065.6682 | 8214852.6618 | 412.4179  | 207       | "1152-121"   |
| 571887.6892 | 8214931.9137 | 0.0000    | 260       | "1152-12122" |
| 572017.3439 | 8214984.5324 | 4044.1401 | 272       | "1152-121"   |
| 571958.4221 | 8215100.1847 | 3362.2724 | 308       | "1152-121"   |
| 571709.1625 | 8214760.5643 | 1955.0926 | 21        | "1152-121"   |
| 571730.9907 | 8214732.1694 | 1299.5685 | 24        | "1152-121"   |
| 571713.3460 | 8214786.9287 | 0.0000    | 43        | "1152-12118" |
| 571783.2205 | 8214756.2836 | 0.0000    | 105       | "1152-12118" |
| 571574.8576 | 8214912.1023 | 0.0000    | 213       | "1152-12118" |
| 571703.9233 | 8214778.9316 | 19.0433   | 281       | "1152-12118" |
| 571992.6963 | 8213912.5891 | 0.0000    | 174       | "1152-12121" |
| 572084.8375 | 8213755.0723 | 1789.9948 | 228       | "1152-121"   |
| 571835.6660 | 8213445.1384 | 0.0000    | 242       | "1152-12121" |
| 572359.6240 | 8213873.5514 | 0.0000    | 297       | "1152-12121" |
| 571784.2114 | 8214426.9089 | 2434.4783 | 97        | "1152-121"   |
| 571931.3922 | 8214485.6970 | 1512.4745 | 135       | "1152-121"   |
| 572036.2034 | 8214730.3707 | 23.3441   | 149       | "1152-12120" |
| 571993.6617 | 8214200.6793 | 1343.5131 | 170       | "1152-121"   |
| 572161.4194 | 8214567.0077 | 277.4777  | 181       | "1152-121"   |
| 571979.3867 | 8214366.0613 | 726.0302  | 192       | "1152-121"   |
| 571627.2186 | 8213819.4025 | 0.0000    | 218       | "1152-12120" |
| 571875.7085 | 8214325.7975 | 0.0000    | 261       | "1152-12120" |
| 572358.6778 | 8213846.7332 | 745.3569  | 155       | "1152-121"   |
| 572394.3452 | 8213872.3629 | 131.7431  | 167       | "1152-121"   |
| 572818.5322 | 8215528.4214 | 0.0000    | 175       | "1152-12123" |
| 572391.2196 | 8214256.6028 | 3674.4552 | 87        | "1152-122"   |
| 572325.7432 | 8214057.8018 | 14.7457   | 98        | "1152-12299" |
| 572268.8969 | 8214146.8811 | 0.0235    | 110       | "1152-12299" |
| 572294.0539 | 8214235.6340 | 2908.3223 | 123       | "1152-122"   |
| 572170.5109 | 8214429.0785 | 1618.6683 | 142       | "1152-122"   |
| 572094.4142 | 8213733.8262 | 0.0000    | 182       | "1152-12299" |
| 572138.7361 | 8214128.4168 | 3653.0309 | 203       | "1152-122"   |

# Field Exercise

1. Working with data
2. Download file from:  
<http://idisk.mac.com/keslerd-Public/migrate>  
\*\*\* click the arrow at the lightning bolt!

1. Start LOAS
2. Open File
  - a. File, Open Data File
  - b. Open file you downloaded
3. Defining File Variables
  - a. Receiver X – select “Easting (x)”
  - b. Receiver Y – select “Northing (y)”
  - c. Bearing Azimuth – select “True Azimuth”
  - d. Group Variables – select “Group and Frequency”



**Assign File Variables**

**Receiver X :** ☐ Lookup List

☐ Group  
☐ Frequency  
☒ Easting (x)  
☐ Northing (y)  
☐ Magnetic Bearing  
☐ True Azimuth

**Receiver Y :** ☐ Lookup List

☐ Group  
☐ Frequency  
☒ Northing (y)  
☐ Magnetic Bearing  
☐ True Azimuth

**Bearing Azimuth(s) :** ☐ Lookup List

☐ Group  
☐ Frequency  
☐ Easting (x)  
☐ Northing (y)  
☐ Magnetic Bearing  
☒ True Azimuth

**Actual Signal Location**

X Coordinate:

Y Coordinate:

☐ Actual Locations In File

**Group Variables**

☒ Group (1)  
☒ Frequency (2)  
☐ Easting (x)  
☐ Northing (y)  
☐ Magnetic Bearing  
☐ True Azimuth

check to enable then select signal location fields.

4. Click Apply

# Play With Field Data

- *Data tab*
- *Results tab*
- *Observer locations*
- *Highlighting bearing groups (sessions)*
- *Exercise*
  - a) *Highlight first bearing group*
  -  b) *Click calculate*
  -  c) *Zoom into center*
  - d) *Notice three bearings, intersections, estimated location.*
- *These are your estimated locations.*
- *Click the “Results” tab for coordinates.*



# Additional Information

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*Millspaugh, J. J., and J. M. Marzluff. 2001. Radio Tracking And Animal Populations. Academic Press, San Diego.*

*White, C. C., and R. A. Garrott. 1990. Analysis of Wildlife Radio-tracking Data. Academic Press, San Diego.*

*Kenward, R. E. 2001. A Manual for Wildlife Radio Tagging. Academic Press, San Diego.*

